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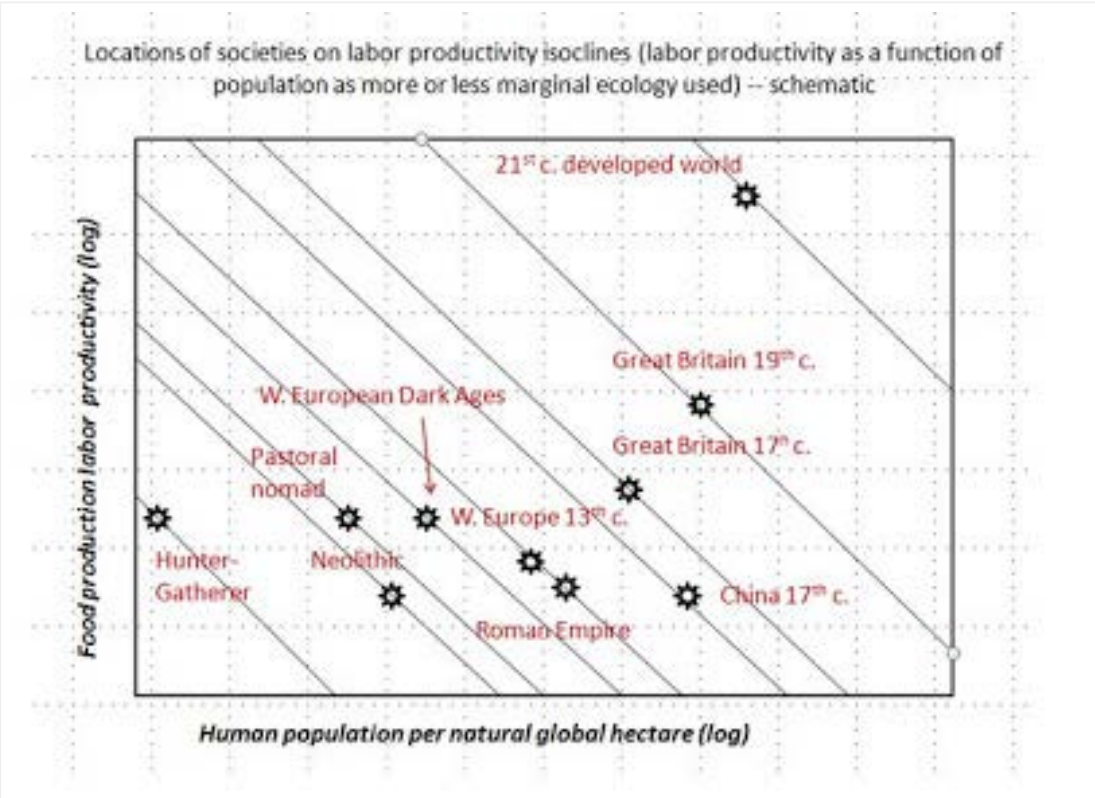
Saturday, December 04, 2010

Some conjectures and facts regarding the Malthusian isocline and the industrial revolution



Reader Matt comments on the Malthusian isocline here,, observing that I placed 17th century Britain a bit "higher" (presumably meaning more advanced, i.e. more "northeast") on the graph than 17th century China.

My placement in this case of one absolutely more advanced than the other is highly conjectural. It's worse than comparing apples to oranges. I had to put them somewhere on the graph and I used my best judgment. Britain was semi-pastoral (yet still stationary) while China had a much more productive climate for grain agriculture (much wetter in the summer and drier in the winter than Britain) and thus could support a far higher population density per hectare. But whether the Chinese population density per hectare adjusted for these natural advantages (presumably leaving technological and institutional differences, what I call denstiy per natural global hectare),

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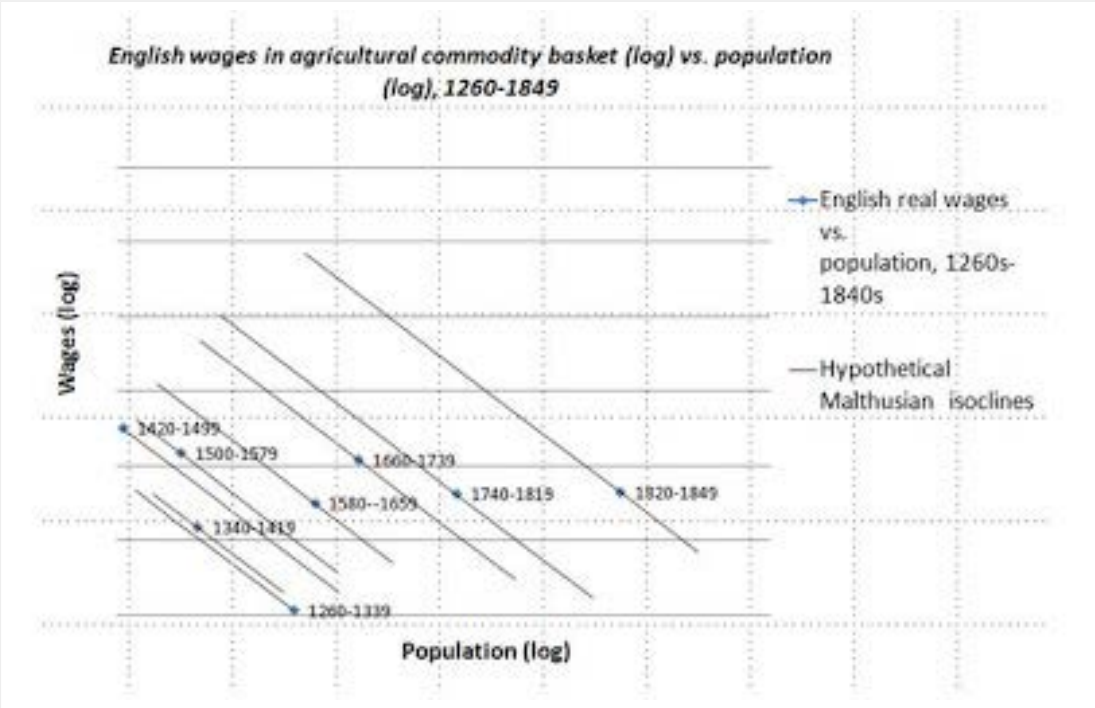
which is what I'm trying to graph on my x-axis, was still much higher is far more conjectural. If we draw the x-axis as just population density per hectare (rather than "natural hectare", i.e. adjusted for natural advantages) the Chinese point is far higher, not just somewhat higher as I drew it, and thus China's isocline was clearly more advanced, but I argue due to natural advantages rather than technology or institutions. In terms of technology and institutions, it's worse than apples to oranges not only because of the radical difference between their basic agricultural strategy (labor-intensive grain-and-bean vs. semi-pastoral and heavy use of draft animals) but each had a number of advanced agricultural techniques the other rarely or never used.

See here and here for the background to these theories and the graph in question, as well as a very interesting film of street scenes that allow us to compare the Chinese and British street transportation in the early 20th century (largely before the IC engine replaced horses and rickshaws).

Note that in contrast to the above graph which is schematic and partially conjectural, the following, showing the relentless advanced of the isocline in England from the Late Middle Ages, is based on actual statistics of population and real agricultural labor wage income based on a food-dominated commodity basket:



This differs from the "noisy until 1800" graph of Clark because I've graphed 80-year averages rather than decadal averages to smooth out the noise of pests and short-term climate variations on the quality of harvests which dominated the position of the isocline before the 19th century. The points are from the data but the slope of the isoclines I drew threw them are still conjectural.

Much less conjectural than the relative levels of European and Asian 17th century isoclines and probably more important for the issue of how Britain escaped from the Malthusian trap is that the British laborer and peasant per capita nutrition (roughly corresponding to real income in an era where food dominated the peasant and laborer budget) was much higher than the Chinese. Britain had more and higher quality protein in the diet (partly from more dairy, which has genetic causes, but mainly from more meat, the British having a stationary yet semi-pastoral agriculture). China, having far fewer draft animals per capita, used laborers for arduous and repetitive tasks the Brits considered fit only for draft animals.

Part of Britain's better marginal standard of living can be put to disease, especially the Black Death, but by the 18th century I'd agree that Britain was as healthy as China. What we see after the Black Death is that the Brits greatly increased their meat-eating and use of draft animals, and, what is more important and seemingly unprecedented, were largely able to keep up this intensive use of livestock

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after their population recovered and even boomed beyond pre-Plague levels, whereas in (AFAIK all) prior agricultural eras and areas increasing human populations in recovery from plagues replaced draft animal with human labor and moved the diet towards grains and away from meat: sliding "souteast" down a static isocline. Also frequent periods of war and excess taxation had often led to the loss of draft animals and their replacement by human labor, in these cases with a regressing (moving "southwest") isocline. In both cases the capital accumulated in draft animals and meat livestock was destroyed. As Steve Sailer correctly points out, in Great Britain there has not been a major famine since before the Black Death while in China they were common until very recently. After the Black Death British agriculture went through a very long period of capital accumulation, in the form of soil conditioners (especially lime), commercial seeds and breeding, engineered water meadows that replaced phosphates and other scarce nutrients, drainage (important in the wet British winters), crops and rotations that fixed more nitrogen (at first growing beans for fodder, then replacing beans with the even better nitrogen fixer clover), and many other improvements besides the tremendous accumulation of livestock. Indeed "improvement" was the watchword of British agriculture as soon as works about it started being published.

So the Chinese peasant and laborer worked harder on a worse diet and lived much closer to starvation, whereas in hard times British peasants could go back to eating the foods that after the Black Death they considered animal fodder (beans, oats, etc.) whereas the analogous soybean was a protein staple of the Chinese peasant as much as it was animal fodder. Again this doesn't tell us whether China's isocline adjusted for its natural advantages was more or less advanced, it tells us that Britain was operating with a higher marginal and mean per capita standard of living and lower population density relative to its natural advantages than China, i.e. further "northwest" on its isocline.

Besides the Columbian Exchange, and even more important, there may have been an even greater but far less heralded exchange going on between Europe and East Asia in the centuries after Europe established regular oceanic contact between the two. Not so much in species, but in techniques and institutions, aided by cheap paper, the printing press, and the resulting expansion of literacy. As this contact increases we see both the East Asian and Western European isoclines advancing rapidly. But the British isocline was advancing faster than Asia's (regardless of which was more advanced absolutely), and probably more importantly in Britain and at least early on the Netherlands were largely maintaining the higher peasant/laborer standard of living despite population growth, whereas in East Asia until the 20th century the isocline started at an already low per-capita income yet the advance was still directly entirely rightward towards higher population growth rather than in catching up to British marginal standards of living. So Britain kept its big lead in per-capita standard of living and farm labor productivity, and thus presumably in the proportion of surplus labor that could be put to work on non-agricultural tasks. And since Britain did not need as large an army as a Continental power, nor as high taxes to support it, more of this labor could go into industry.

Another major factor in industrialization was urbanization, that is the proportion of this surplus labor that could be relocated where other industry or industrial resources were available rather than to where the food was grown. Urbanization (and presumably the general proportion of non-agricultural population) during the 17th-19th centuries was growing rapidly in both Western Europe, especially Britain, and Tokugawa Japan but less so in China, a phenomenon I have yet to see explained (draft animals can't explain the Japanese case as they resembled China in being relatively bereft of them). As far as agriculture and urbanization goes, contrary to myth Tokugawa Japan saw great progress, almost as much as Britain during the same period, albeit much less technological progress in industry than Britain. Urbanization depended most on water transport, i.e. the ability to transport grain to remote regions (the same thing that made ancient Rome a very large city, in her case grain imports across the Mediterranean from Sicily and Egypt). Without good water transport labor beyond that needed for agriculture had to stay in the rural areas near where the grain was grown. Japan, Britain, and the Netherlands had good water transport with many farmers near navigable water due to geography and engineering to extend the navigability of rivers and especially in the Netherlands to build canals which served a triple role of defense barrier, water control for reclamation of formerly submerged areas, and transport. Britain and the Netherlands also had an advantage in that their preferred and available source of protein, beef, could be transported over long distances over land on the hoof, whereas the pigs, fowl, and soybeans of the Chinese required water transport. Urbanization and industrialization also required transport for fuel (wood and coal: forests near navigable water were soon denuded and forests far from navigable water were generally useless. The Brits could use far more forest area per capita because their draft animals could transport more timber and fuel farther. Both the Brits and

Chinese had ample and easy-to-mine coal but only in Britain were there mines within ox- or horse-transport distances of navigable water combined with a plentiful supply of these draft animals, which explains why Britain was possibly mining more coal than the rest of the world combined by the 17th century. Horse gin powered pumps also drained the British coal mines before the dawn of the Savery and Newcomen steam engines).

China had for many centuries also had good water transport due to the Grand Canal and its tributaries, but perhaps because of its artificial and inland nature it was far more bureaucratically controlled and subject to excess taxation and other institutional problems than the coastal transport in Japan and Britain. Japan, with its long and thin coastline, probably had the greatest amount of farmland next to coastline controlled by peoples speaking a single language and thus able to trade food with low transaction costs. But Britain's advantage in draft animals more than made up for having a fatter island, as their horses probably made four or more times as much farmland accessible to the navigable water than the mostly human-powered Japanese transport, and its horses also increased the efficiency of river navigations and (eventually) canals. After the railroad, and even moreso the IC engine, reached Japan it quickly caught up to and leapfrogged ahead of Britain (something Clark's theory can't explain).

Posted by Nick Szabo at 4:11 PM

2 comments:

EricT said...

Has anybody tried to come up with a nutrient budget showing how much NPK was available in the soil? I can't think of any archeological artifact one could test today to determine the soil levels hundreds of years ago, but perhaps one could reconstruct the inputs and outputs or try to recreate the farms in their original conditions to see what the NPK flows were.

6:05 PM

nick said...

The only attempt at a nutrient budget for the agricultural revolution I've seen: Robert Allen has a computer model of nitrogen sources and consumption. I haven't tried to get the code or run it, but it looks interesting. However, it focuses on nitrogen leaving out other important nutrients and neglects some nutrient-replenishing technologies such as water meadows.

12:35 AM

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